# Bucknell University's
# Grand Challenge Scholars Program
# Operational Document

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## Contents

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## Introduction

The [National Academy of Engineering](#) (NAE) has identified 14 [Grand Challenges](#) facing all people that require both technical solutions and non-technical perspectives.  Examples include Make solar energy economical, Manage the nitrogen cycle, Provide access to clean water, Advance health informatics, Reverse-engineer the brain, Secure cyberspace, and Advance personalized learning.  The NAE has also encouraged universities to establish [Grand Challenge Scholars Programs](#) (GCSP) to encourage and equip students to tackle these problems.  Grand Challenge Scholars are required to complete all five components of a GCSP, including interdisciplinary coursework and research, gaining global and entrepreneurial perspectives and experiences, and engaging in related service-learning.  Bucknell University's [Grand Challenge Scholars Program](#) (GCSP) was approved by the National Academy of Engineering's (NAE) [GCSP Steering Committee](#) in April 2013 based on a revised proposal that was approved by the Dean of Engineering, the Registrar and the Provost.

This document describes Bucknell's vision for its GCSP, identifies the options for how each of the five GCSP curricular components can be completed, describes how the GC Scholars are selected and tracked and identifies the members of the GCSP Steering Committee.  The document identifies differences in GCSP requirements between our original approved proposal and the current way the program is run.  The document's intended audience includes both Bucknell faculty and administrators who wish to know more about the GCSP as well as GCSP Directors at other institutions who wish to learn how GCSPs have been implemented elsewhere.

## Bucknell's Vision for a GCSP

Established in 1846, [Bucknell University](#) is a liberal arts university with strong professional programs, including a [College of Engineering](#) (CoE) that is consistently ranked among the best in the U.S. for undergraduate engineering education.  Our liberal arts setting has always fostered an understanding within the CoE that an engineering education must include substantial breadth, including natural science, social science and humanities courses that provide the necessary broad perspectives needed for effective technical solutions.  In recent years, with the growth in our interdisciplinary courses and programs and influential publications such as the [NAE's "Engineer of 2020"](#) we have actively sought mechanisms to more effectively integrate engineering and non-engineering courses and to achieve truly-broad minded engineers with excellent technical skills.  Even more recently, our increased focus on student engagement, the establishment of an [Office for Civic Engagement](#) and a [Teaching and Learning Center](#), and the launch of a $500 million comprehensive [campaign](#), has galvanized us to establish formal programs to better provide our engineering students with the needed broad education and rich residential undergraduate experience.

We established a GCSP because we believe the fourteen Grand Challenges are important and worthwhile endeavors and that we should encourage many of our graduates to contribute to solving one or more of the Challenges.  We also believe the NAE's GCSP provides an excellent vehicle for motivating a voluntary group of students to increase their academic engagement throughout their years at Bucknell by taking advantage of the existing strong opportunities for pursuing each of the required GCSP components.

Our vision is to have our GCSP help ensure all GC Scholars achieve the broadened education and deeper engagement communicated in the College of Engineering's Plan for Engineering Education, and to be motivated and equipped to help solve a Grand Challenge. Moreover, we envision the GCSP will also help achieve similar goals for other engineering students who are not formally designated as GC Scholars, that is, we anticipate positive spillover effects throughout the CoE and the University as a whole.

Bucknell expects its GC Scholars to be able to recognize and act on their ability to make real efforts towards solving the world's Grand Challenges. GC Scholars will create innovative ideas that will solve the most pressing issues of today to meet the basic needs of all people and work for a higher standard of living. Bucknell expects them to understand that it takes people from various disciplines to solve these problems, which must be considered from different angles. They will work to build their entrepreneurial skills, which will allow them to take their ideas into the business world. Furthermore, GC Scholars will realize both that they work in a global environment and that they work to serve the public and improve the general welfare of all people. Finally, GC Scholars will network with other GC Scholars at Bucknell, at other schools, and with professionals involved in solving the Grand Challenges in research and industry.

## Program Elements:

This section of the proposal describes ways that Bucknell GC Scholars can fulfill each of the five components of the GCSP required by the National Academy of Engineers and is summarized in Appendix 1. Each senior who is acknowledged by the GCSP Steering Committee to have completed their GCSP requirements by April 15 will receive a certificate from the NAE designating him/her as a Grand Challenge Scholar and will have her/his GCSP affiliation noted on the transcript.

**Research Experience**

All GC Scholars are required to execute a substantial research project related to a Grand Challenge. Such research projects must be overseen by a faculty member and result in a tangible work product, such as a scholarly paper, report, poster presentation, conceptual design and/or prototype. Research projects must involve at least 60 hours of work but are expected to typically involve many more hours, as is associated with a full-time summer research position or an independent study during the academic year. GC Scholars are expected to propose a GC-related research project, identify a faculty advisor who is willing to supervise the research, and secure their own funding (if during the summer), most commonly through the stipend-paying Program for Undergraduate Research during the summer. Students are strongly encouraged to consult with the GCSP Director or a member of the GCSP Steering Committee (which is discussed later in this document) before the research is begun to confirm it is sufficiently related to a Grand Challenge.

Scholars who have difficulty in identifying an appropriate research project or faculty research supervisor are encouraged to seek advice with one or more members of the GCSP Steering Committee. In addition, the GCSP Director may be able to help the student secure summer funding from the GCSP Fund and/or the student's department.

A student accepted into GCSP who has already completed research that can be approved for completing the research requirement must submit a request for approval to the GCSP Director that summarizes the research questions, methodology and findings from the research, the connection to one or more Grand Challenges, and the approximate number of hours expended on the project.  The GCSP Director may wish to discuss the research project in person with the student and/or the faculty research adviser.

Once a research project is completed, each GC Scholar is strongly encouraged to present his or her research through a poster presentation at the existing Kalman Research Symposium and Sigma Xi Research Presentation program at Bucknell.  In addition, each senior Scholar is required to present his or her research at GCSP Senior Showcase held in the spring.


**Broadening Curriculum**
In accordance with the NAE's GCSP guidelines, GC Scholars at Bucknell are required to complete a curriculum that prepares them to "work at the boundary between an engineering and non-engineering discipline."  This curriculum includes the special GCSP course described shortly and a set of relevant electives, including social science and humanities electives, technical electives and discipline-specific electives.

Regarding the special GCSP course, all GC Scholars are required to take an interdisciplinary course developed exclusively for the GCSP called "The Grand Challenges."  During the 2013-14, 2014-15, and 2015-16 academic years, the course was a 1.0 credit (i.e., equivalent to 4 credit hours) first-year foundation seminar that introduced students to all fourteen Grand Challenges, focused on 3-5 specific GCs to help the students understand the multidisciplinary nature of the GCs, and introduced fundamental concepts and tools that are relevant to solving Grand Challenges, such critical perspectives on technology, economics, finance, management of innovation, and public policy.  This course was taught by the GCSP Director as a foundation seminar in the [Society and Technology Residential College](.).

As is true for all [foundation seminars], this course was capped at 16 students, counted as a Writing 1 (W1) course, and met the course objectives pasted below.
> Foundation seminars introduce first-year students to the learning community in which they are expected to participate actively while at Bucknell. Through a wide variety of activities, students come to value and to emulate the characteristics of an engaged learner. In particular, they take responsibility for their own learning and understand how specific activities are related to the learning goals of a course. They take an active role in evaluating their own learning, and if necessary, seek assistance in order to achieve the learning goals. They can apply and transfer knowledge across disciplines and can make connections at various levels. They are aware that learning is a social act that requires collaboration and self-awareness as well as being receptive to constructive criticism and alternative ideas or solutions.
> Students improve their ability to analyze, evaluate, and interpret materials they encounter to synthesize and communicate the results of their studies, and to create works of their own. This process fosters critical thinking skills complemented by the creative dimensions of imagination and insight. Through exposure to different perspectives, students come to realize the limitations of a single viewpoint, while learning to construct persuasive arguments based on close analysis of multiple viewpoints.

Accepted students who did not take the GCSP foundation seminar have been required to complete a set of non-credit bearing online modules developed by the GCSP Director that capture the key topics identified earlier for the foundation seminar. Each module consists of a set of lecture notes, required readings, and an assessment worksheet that typically requires 2-3 hours to complete. In some cases, Scholars who clearly learned the content of a module through another course have had the module waived by the GCSP Director. For example, the public policy module can be waived if a student has taken one of the five public policy courses identified on the GCSP website, the Introduction to Economics module can be waived if the student has taken ECON 103, and the Financial Analysis module can be waived if the student has had a course in engineering economy.

Beginning in the fall of 2017 (when the GSCP Director returns from sabbatical), the entry course for the GCSP is expected to be a new 200-level UNIV course called "The Grand Challenges." (This course will be submitted for approval in the fall of 2017. Because UNIV courses now count for engineering general education requirements, the course will have to be approved by both curriculum committees. If this course is not approved, the previously approved foundation seminar will continue to be offered.) The objectives and content of the course are not expected to change significantly from the foundation seminar, other than what is appropriate for a 200-level course. This course will be interdisciplinary but not an Integrated Perspectives course because it will be taught by only one faculty member. It is expected to be targeted for sophomore engineering students but open to all majors.

There are several reasons why the GCSP entry course is planned to shifted from a foundation seminar to a second-year course. One reason is that many students hear about the GCSP after they arrive at Bucknell, which is too late to enroll in the GCSP foundation seminar. A course offered to sophomores and juniors should be a more visible and viable elective. However, it may still be necessary in unusual circumstances to waive this course and require the student to complete the online modules instead. A second reason is that foundation seminars are capped at 16 students. The new course is expected to have a 35-student cap. A third reason is that engineers are only allowed to take foundation seminars within a residential college. Teaching residential College foundation seminars require considerably more instructor time than do normal foundation seminars, and the GCSP Director will no longer be able to commit this extra time.

The original approved proposal to establish a GCSP at Bucknell stated there would be a second required GCSP course. This 1.0 credit course was expected to consist of an intensive three-week, all-day course delivered immediately after Bucknell's Commencement, followed by independent work on a major research paper that is completed while the student participates in a summer internship or summer school. The course was intended to allow the students to complete at least one of their GCSP requirements and involve travel off campus. For example, in 2015, the course was entitled "Entrepreneurship and Renewable Energy in Iceland" and allowed the students to complete their entrepreneurship and international perspectives requirements. In 2016, the course will be entitled "Social Entrepreneurship in New Orleans" and will allow students to complete their service-learning and entrepreneurship requirements while focusing on the renewing infrastructure Grand Challenge.

For several reasons, the requirement for Scholars to participate in a three-week summer course will be eliminated after the 2016 course. One reason is the cost for this course. The cost to Bucknell for the Iceland course was over $5,000 and for the New Orleans course was around $3,000. Nearly half of the Scholars accepted to date receive substantial financial aid during the academic year, so it did not seem appropriate to require an additional course beyond their degree requirements without offering them significant financial aid. Several Scholars who do not receive financial aid during the academic year stated they could not afford the three-week summer course. A second reason for eliminating the summer course is the perception that there is already a plethora of three-week study abroad courses, including ENGR 290 and courses that often run in Denmark, South Africa and Nicaragua. A final reason not to require the three-week GCSP course is that it will likely prove increasingly challenging to identify a faculty member willing to teach it.

It should be noted that eliminating the second course will not affect the NAE GCSP National Steering Committee's approval of Bucknell's GCSP. There is no GCSP-focused courses required by the NAE and the National Steering Committee has acknowledged that not all GCSPs will be implemented exactly as set forth in their approved proposal.

There is no required GCSP course during GC Scholars' junior year. Instead, students complete their core engineering curriculum, their social science and humanities requirements, and perhaps participate in an independent study research project under the supervision of a faculty member. Scholars are encouraged to work with Bucknell's Career Development Center to secure a summer internship relating to their Grand Challenge or in an entrepreneurial organization. Grand Challenge Scholars who do not wish to study abroad will be encouraged to consider participating in the Bucknell in Washington (DC) program that is being developed as they will likely be exposed to relevant public policy issues.

There is also no required course for GC Scholars during their senior year, but the GCSP Steering Committee hopes to begin encouraging GC Scholars to participate in a senior design project that is related to one or more Grand Challenges. Senior design projects within Bucknell's College of Engineering are typically supervised by a set of faculty members in each department (rather than by one course instructor) and change year to year. It is possible in most departments for a student to suggest a project, secure a faculty supervisor, and have other interested students assigned to the design team. In departments where students are typically not allowed to suggest projects, the GCSP Director will work with senior design project faculty to identify design projects that are related to the Grand Challenges and aligned with faculty interest and expertise.

Regarding the relevant set of electives chosen by each GC Scholar, all Bucknell engineering students are required to take five social science and humanities electives in addition to ABET-required courses in Mathematics, Chemistry, Physics and engineering sciences. Depending on a student's major and whether she entered Bucknell with AP or IB credits, engineering students also get to take 1-6 free electives. Once a GC Scholar identifies the Grand Challenge she is most interested in pursuing, she is encouraged to discuss with her academic advisor and a three-person subcommittee of the GCSP Steering Committee which courses will best prepare her for the Grand Challenge-related research, entrepreneurial activity, senior design project, graduate school and career she envisions. (This advice is explicitly framed as complementing, not replacing the course and other guidance provided by the student's academic adviser.) Bucknell's approved

proposal included a list of approximately 66 existing courses that the GCSP Director believed would prove beneficial to students interested in one or more of the 14 Grand Challenges (see Appendix 2). This list of course was provided for informational purposes only. No GC Scholar is required to take any of these courses. While the GCSP website does state that GC Scholars are encouraged to ECON 103 and one of five identified courses in public policy, the GCSP Steering Committee has never received any indication that this encouragement has caused any problems for the departments offering these courses.

**Entrepreneurship**
Because it is important for students of all disciplines to understand the way business functions in our world and the process of commercializing new technologies, all GC Scholars at Bucknell are required to complete some form of entrepreneurship activity. Approved entrepreneurial activities for GC Scholars are listed below.

1) Completing the 2015 and 2016 GCSP three-week summer courses, which were explicitly intended to satisfy the entrepreneurship requirement.
2) Completing the KEEN Winter Interdisciplinary Design Experience (K-WIDE) or B-FAB workshop.
3) Completing any of the IDEAs studio courses.
4) Participating in the Business Pitch Competition at Bucknell held each fall or a similar completion involving pitching a new business or creating a business plan.
5) Completing three to five seminars regarding topics of entrepreneurship, business, and/or intellectual property offered by Bucknell's Small Business Development Center (SBDC) on a regular basis.
6) Securing an internship or other experience that explicitly involves a high degree of innovation, invention or related activity, such as an internship or other formal involvement with the Bucknell Entrepreneurs Incubator, or an extended externship with an entrepreneur or within an entrepreneurial organization.
7) Serving as a student consultant to the members of the outside community working with the SBDC.
8) Involvement with a venture identified and initiated by the student and approved by the GCSP Steering Committee.

**Global/Cross Cultural Dimensions**
We live in an interdependent world where we must cross cultural barriers on a regular basis to achieve many of the answers to our most pressing problems. Thus, the relevance of having a background that permits one to effectively overcome these barriers and work cohesively with others from around the world cannot be overlooked. All undergraduate engineering students at Bucknell currently are required to pass a course that is designated as a Global and Societal Perspectives course. GC Scholars at Bucknell will be required to complete an additional global awareness activity in order to understand the global aspects of the problem they are trying to solve and the contextual challenges to implementing solutions. Acceptable activities are expected to include international travel as we believe it is difficult to fully appreciate cultural context without visiting a country; however exceptions will be made due to financial issues. Bucknell engineering students are already well positioned to study abroad due to an International Education Committee within the CoE that works to eliminate curricular barriers to study abroad and a professionally-staffed Office of Global and Off Campus Education that liaisons with

approved programs and works with engineering students to facilitate the study abroad process. Currently, approximately 30% of Bucknell engineering students study abroad for a semester or as part of ENGR 290.

Acceptable activities will include:
1) Studying abroad, either for a complete semester or through the CoE's three-week course ENGR 290 Engineering in a Global/Societal Context, or the GCSP summer course when it explicitly included international study;
2) Completing a summer internship abroad;
3) Participating in a service trip abroad, such as the Bucknell Brigade's January and March trips to Nicaragua, the BACES trip to the Dominican Republic, or a Bicycles Against Poverty trip to Uganda;
4) Any other global dimension activity proposed by the student that involves international travel and is approved by the GCSP Steering Committee.

**Service-Learning**
Bucknell has long valued civic engagement and has already incorporates service into many aspects of its students' daily life. Greek organizations, clubs, and sports teams are required to do service work. The establishment of a professionally-staffed Office of Civic Engagement several years ago has increased the number of service-learning courses as well as non-course opportunities for service-learning. All GC Scholars are required to complete a service-learning experience to ensure they understand their responsibility to the public as an engineer and as a citizen, as well as to better understand the contextual challenges associated with implementing technical solutions.

Acceptable service-learning activities will include:
1) Participating in an approved week-long service trip, such as the Bucknell Brigade's trip to Nicaragua, the BACES trip to the Dominican Republic, the Katrina Recovery team's trip to New Orleans, one of the annual week-long service trips by Bucknell's Habitat for Humanity chapter, or the GCSP summer course when it explicitly focused on service-learning;
2) Completing one GCSP Steering Committee-approved service-learning course[1];
3) Completing a senior design project or other project that involves significant service-learning;
4) Completing an independent service-learning project approved by the Assistant Director of Service-Learning and the GCSP Director;[2]
5) Another significant service-learning experience approved in advance by the GCSP Steering Committee.

**Curricular Impact Summary**
It is important to note that out of the five GCSP requirements, the only component that requires a course is the broadening curriculum requirement. Specifically, GC Scholars will be expected to

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[1] MGMT 101 is officially a service-learning course but the service-learning experiences vary widely with the project and the student. As such, Scholars seeking to have their MGMT 101 experience count towards their GCSP requirement must request approval from the GCSP Director.
[2] Appendix 3 includes a guidance document and approval form for independent service-learning projects.

take the new 200-level UNIV course called "The Grand Challenges" that is expected to be offered for the first time in 2017. (As stated earlier, this course replaces The Grand Challenges foundation seminar that was offered in 2013, 2014 and 2015.) Because this course is expected to be taught by the GCSP Director, there is no chance that the course requirement will affect a course instructor who was not aware of the requirement. The research, study abroad, entrepreneurship, and service-learning components can all be completed without a Scholar having to take an additional course. In short, the GCSP can be considered an academic and co-curricular program that is not anticipated to have any significant course or curricular impacts.

## Selection and Program Management:

Bucknell's approved proposal to establish a GCSP stated the program would be open to all undergraduate engineering students with a GPA above 3.0. The selection criteria have since changed in two ways. First, we have relaxed the GPA requirement after discussions that led to the realization that the goals of our GCSP—motivating and equipping students to tackle one of the Grand Challenges—are not well served by enforcing a debatable cut off value for a metric that likely disadvantages students from under-resourced high schools. Second, we are currently accepting non-engineering students on a trial basis. In the same way that GC Scholars who are engineering majors are expected to take relevant social science and humanities courses, GC Scholars who are non-engineering majors are expected to take relevant technical courses. Appendix 2 identifies technical courses that may be appropriate for both engineering majors and non-engineering majors.

Students are selected to be GC Scholars through two paths. One path is by taking the GCSP foundation seminar or the future 200-level UNIV course discussed in the Broadening Curriculum section of this document. Foundation seminars are mandatory for all non-engineering first-year students but optional for first-year engineering students. Students who earn at least a B in the GCSP foundation seminar or UNIV 200 course and effectively demonstrate their interest in the Grand Challenges through their course term paper will automatically be accepted into the GCSP.

Students who do not take the Grand Challenges foundation seminar or UNIV course but want to become a GC Scholar will be considered by the GCSP Steering Committee once they submit their application during their second or third year. The GCSP Steering Committee has to date simply requested applications through an email, but intends to start offering an optional evening information session that will summarize the GCSP and the application process. Each applicant is required to submit through a Google Drive system:
- A completed application form that indicates their major, GPA, and home country;[3]
- An essay that discusses why the applicant wishes to become a Grand Challenge Scholar and an essay that discusses what the applicant would bring to the GCSP;
- An academic adviser endorsement form[4];
- Academic Progress Report, which identifies the courses taken and grades received at Bucknell.

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[3] The GCSP application form is provided in Appendix 4.
[4] The faculty adviser endorsement form is provided in Appendix 5.

To date, all applicants have been accepted into the Program.  Selection decisions reflect the desire for GC Scholars to be a diverse cohort of intellectually strong students with demonstrated passions for one or more Grand Challenges.  Nearly half of the current 50 Scholars are non-male (female or transgender) and nearly half are non-Caucasian, but if the diversity within the GCSP ever becomes insufficient, the GCSP Steering Committee will work with the Office of International Student Services, the Office of Multicultural Student Services, the Office of LGBT Awareness and the Associate Dean of Engineering who oversees the [Engineering Success Alliance](#) to increase diverse student interest in the GCSP.

Once selected to be part of the GCSP, each student is required to report (through a shared Google Doc) their progress towards completing their GCSP requirements.  Each Scholar is expected to meet with one or more members of their GCSP Steering Committee subcommittee at least once per year to discuss their progress and the broadening courses they plan to take.  In addition, GC Scholars are expected to attend 1-2 special lectures that are planned for each semester as well as the GCSP Showcase described below.

Seniors are required to participate in a GCSP Showcase to be held each April.  Each senior will present how they achieved the required components of the GCSP through a poster or formal presentation.  In addition, each senior GC Scholar will be required to create an e-portfolio that will be featured on the [GCSP website](#).  This website will provide information regarding the various aspects of the program for potential applicants and interested alumni, as well as provide students with examples of how past GC Scholars have been successful.

## GCSP Governance

The GCSP Steering Committee consists of the GCSP Director, an Associate Dean of Engineering (unless the GCSP Director is an Associate Dean), an Associate Dean from the College of Arts & Sciences, one tenured faculty member from each of the six engineering departments appointed by the department chair, a faculty member associated with Bucknell's Institute for Public Policy, a research librarian who specializes in engineering research, the Director of the Office of Civic Engagement, the Executive Director of the Career Development Center, and a physician and health researcher at Geisinger Medical Center.  The current members of the Steering Committee are listed in Appendix 4.  The Committee members serve on a voluntary basis and do not receive course release or financial remuneration.

The GCSP Steering Committee meets 1-3 times per semester.  Activities of the committee include:
- Advising the GCSP Director on strategy and operational issues, in order to facilitate continuous improvement;
- Participating in and/or overseeing the Scholars selection process;
- Helping to link individual GC Scholars with research opportunities, especially within their departments or within interdisciplinary groups with whom they collaborate;
- Helping to advise individual GC Scholars on course selection and on how to complete other components of the GCSP Program;
- Liaising with faculty and staff associated with their departments on GCSP matters as needed;
- Identifying potential guest speakers; and

- Suggesting topics and skills to be included in the GCSP course.

Committee members may communicate concerns about the program directly to the Dean of Engineering if needed.

## Resources

The resources needed to launch and maintain Bucknell's GCSP have been obtained through various mechanisms. Dean of Engineering Keith Buffinton appointed Assoc. Dean Mike Toole to be the GCSP Director, thereby providing the administrative leadership needed to launch the program. Prof. Toole's department chair has allowed him to teach the GCSP foundation seminar. The members of the GCSP Steering Committee serve on a voluntary basis.

The costs for the foundation seminar were covered by standard academic year tuition. The costs for the summer courses were and will be paid through a combination of summer school tuition charged to the students (approximately $2600), a program fee charged to the students (approximately $2400 for the Iceland course), funds donated by alumni to launch the GCSP ($185,000 in total), and funds donated to the College of Engineering and approved by the Dean on a year-to-year basis for the GCSP. Costs for GCSP lectures, dinners and site visits during the academic year will be paid through the funds donated to the GCSP.

## Closing

The Grand Challenge Scholars Program is an exciting undergraduate educational initiative that matches well with Bucknell's educational goals and opportunities. The GCSP's origin and continued affiliation with the National Academy of Engineering not only suggest that the program as a whole is a credible innovation, but that Bucknell's initiatives in the individual components of the GCSP—entrepreneurship, service-learning, study abroad, interdisciplinary courses and research—are affirmed by national engineering education leaders. The summary of the accomplishments of the first three years of the GCSP program provided in Appendix 6 indicates the courses and research associated with the GCSP has promoted interdisciplinary learning and faculty collaboration. Students have been incentivized to take advantage or one or more transformative experiences that they may not have otherwise pursued. In short, Bucknell's GCSP has been successfully launched and the GCSP Steering Committee is confident we have the commitment, infrastructure and resources to continue to grow a successful GCSP at Bucknell.

# Appendix 1:  Summary of Options for Completing GCSP Required Components

| Curricular Components | Requirements |
|---|---|
| **Research Experience** | Complete an independent research project over a summer or one or more semesters.  The Project must be approved by the GCSP Director and presented at the GCSP Senior Showcase. |
| **Interdisciplinary Curriculum** | Complete the Grand Challenge Foundation Seminar OR future 200-level UNIV course OR the on-line GCSP modules and consider guidance from the Scholar's GCSP subcommittee and academic adviser on what broadening courses would be most relevant to the Scholar's Grand Challenge of interest. |
| **Entrepreneurship** | Completing ONE of the following activities:<br><br>1) the 3-week GCSP summer course when it explicitly focuses on entrepreneurship,<br><br>2) the KEEN Winter Interdisciplinary Design Experience,<br><br>3) the BizPitch Competition,<br><br>4) any of the IDEAS studio courses,<br><br>5) an approved internship or other experience that explicitly involves a high degree of innovation, invention or related activity,<br><br>6) approved consulting to an outside organization working with the SBDC,<br><br>7) approved involvement with a venture initiated by the student. |
| **Global Dimension** | Completing ONE of the following activities:<br><br>1) studying abroad, either for a complete semester or as part of ENGR 290 or the 3-week GCSP summer course when it goes abroad<br><br>2) an approved summer internship abroad<br><br>3) a service trip abroad, such as a Bucknell Brigade trip to Nicaragua, the BACES trip to the Dominican Republic, or a Bicycles Against Poverty to Uganda<br><br>4) an approved global dimension trip proposed by the student |
| **Service-Learning** | Completing ONE of the following activities:<br><br>1) an approved 30 hour service-learning project<br><br>2) an approved week-long service trip, such as the Bucknell Brigade, the BACES trip to the Dominican Republic, the Katrina Recovery team's trip to New Orleans, or a Habitat for Humanity build trip<br><br>3) an approved service-learning course<br><br>4) an approved senior design project or other project that involves significant service-learning<br><br>6) the 3-week GCSP summer course when it explicitly focuses on service-learning<br><br>5) another service-learning experience approved in advance |

# Appendix 2: Current Grand Challenge-Related Courses

Some but not all of the courses that are relevant to one or more the NAE's Grand Challenges are listed below. Courses that would help provide liberal arts GC Scholars with needed technical information are marked with an asterisk.

## Energy and Environment

BIO 415 Conservation Biology*
CHEM 360 Advanced Environmental Chemistry*
CENG 320 Water Resources Engineering*
CENG 340 Introduction to Environmental Engineering*
CENG 421 Hydrology*
CENG 431 Intro. to Urban and Regional Planning*
CENG 442 Sustainability Principles for Engineers*
ECON 238 Urban Economics
ELEC 494 Renewable Energy Systems*
ENGR 262 Introduction to Energy Resources*
ENGR 290 Engineering in a Global/Societal Context

ENGR 291 The Global Engineer
ENST 201 Environ. Problems-Sustainable Futures*
ENST 262 Introduction to Energy Resources*
ENST 347 Sustainable Cities*
GEOG 236 Third World Development*
MECH 422 Renewable Energy Conversion*
PHYS 147 Energy and Sustainability*
POLS 291 Environmental Policy and Politics
RELI 226 Environmental Ethics
UNIV 266 Sustainable Building Design*

## Health

BIO 304 Biology of Cancer*
BIO 130 Health and Disease*
BIO 347 Virology*
BMEG 205 Bioinstrumentation I*
BMEG 210 Fundamentals of Biomedical Engineering*
BMEG 250 Fundamentals of Biomechanics*
BMEG 300 Biotransport I*
BMEG 400 Biotransport II*
BMEG 408 Medical Device Assess. and Develop.*

BMEG 451 Biomechanics and Injury Prevention*
ECON 237 Health Politics and Health Policy
ECON 312 Health Economics
MECH 476 Biomechanics*
NEUR 100 Introduction to Neuroscience*
PHIL 272 Philosophy of Biology
PSYC 211 Health Psychology
PSYC 318 Cognitive Aging
SOCI 208 Methods of Social Research

## Security

CHEG 330 Process Control
CHEG 400 Process Engineering
CSCI 240 Computers and Society*
CSCI 362 Computers and Network Security*
CSCI 367 Computer Graphics*
ECON 220 Introduction to Public Policy
GEOG 210 Urban Condition

IREL 250 Theories of International Relations
IREL 275 Global Governance
IREL390 American Global Strategy
PHIL 233 The Philosophy of Peace and Nonviolence
POLS 170 International Politics
SOCI 346 Utopia/Dystopia in Urban Latin America

## Joy of Living

BIO 343 Neural Plasticity*
BIO 342 Neuroethology*
BIO 332 Developmental Neurobiology*
BMEG 461 Brain, Mind, and Culture*
BMEG 409 Fabrication and Experimental Design
CSCI 203 Introduction to Computer Science*
CSCI 240 Computers and Society

EDUC 328 Tests and Measurement
EDUC 339 Inclusive Practices
EDUC 347 Family, School, and Comm. Partnerships
NEUR 344 Developmental Brain Research*
PHIL 204 Scientific and Everyday Reasoning
PSYC 207 Developmental Psychology
SOCI 315 Educational Policy and School Organization

# Appendix 3:  Independent Service-Learning Project Guidance and Form

## GCSP Service-Learning Project Requirements
Bucknell University Grand Challenge Scholars Program

**Introduction**
All Bucknell Grand Challenge Scholars will be required to complete a service-learning experience to ensure they understand their responsibility to the public as an engineer and as a citizen, as well as to better understand the contextual challenges associated with implementing technical solutions.  A common contextual challenge is that American engineering students do not understand the micro-cultural differences and economic challenges that exist within communities where Grand Challenge solutions could be most useful.  As such, service-learning projects should ideally involve meaningful interaction with people with different socioeconomic backgrounds than your own.  Also, service-learning projects should provide Scholars with knowledge and experiences relevant to the Grand Challenge(s) of interest to them and that will better enable them to achieve their academic and career goals.  This document identifies approved service-learning activities and the process for completing these requirements.

**Service-Learning Options**
Acceptable service-learning activities are listed below:
1) Participating in an approved week-long service trip, such as the Bucknell Brigade's trip to Nicaragua, the BACES trip to the Dominican Republic, the Katrina Recovery Team's trip to New Orleans, or one of alternative breaks trips associated with Habitat for Humanity, the Appalachia Service Project, or other organizations that are at least one week-long and focuses on service.
2) Completing one GCSP Steering Committee-approved service-learning course (use the Course Information search tool within MyBucknell/Banner Web to search for Service-Learning Courses being offered each term, or contact the Office of Civic Engagement).
3) Enroll in a 3-week GCSP summer course with a focus on social entrepreneurship and contains a service-learning component (planned for May 2016).
4) Completing a senior design project or other project that involves significant service-learning and is approved in advanced by the GCSP Steering Committee.
5) Another significant (at least total of 30 hours) service-learning experience approved in advance by the GCSP Steering Committee.  For example, completing a project for one of the local non-profit organizations that partner with Bucknell's Office of Civic Engagement.

**Process**
The GCSP Steering Committee views the GCSP Service-Learning requirement as a valuable tool for enhancing student learning, but does understand that it places substantial expectations on participants.  Therefore, the Committee strives to make the process as simple as possible, ensuring that each Scholar's experiences meet the goals of the requirement, without being cumbersome to the student.  As such, the process consists of three steps:  getting approval from the GCSP Director before beginning the service-learning activity (based on consultation with participating programs or organizations as needed), completing the service-learning project, course, or program, and submitting an acceptable reflection on the experience.

1) Pre-Approval.  Scholars wishing to satisfy their service-learning requirements through approved activity 1 (service trip) or 2 (service-learning course) need only send an email to the GCSP Director and the Scholars Faculty-Staff Committee describing the service-learning activity that will be completed and how it will achieve the goals of the service-learning requirement and is related to their Grand Challenge(s) of interest.  Scholars interested in pursuing an appropriate senior design project should first discuss their intention to do this with member of their Faculty-Staff Committee and/or the GCSP Director.  Scholars intending to pursue an independent service-learning project should identify a faculty or staff member willing to oversee the work and complete the Agreement form that can be accessed [here](here).

2) Activity Completion.  Scholars should complete the service-learning activity in accordance with any guidance received from their project supervisor, member of the GCSP Steering Committee, and/or staff member of the Office of Civic Engagement.  Any concerns about health and safety should immediately be reported to the project supervisor.

3)  Post-Completion Reflection.  Scholars should submit to the GCSP Director (and their independent project supervisor, if applicable) a 500-1000 word reflection that describes the experience, discusses whether the anticipated service and learning objectives were met, discusses what lessons they learned that are relevant to course concepts and/or the grand challenges, and identifies suggestions (if any) for how to make similar experiences better for future Grand Challenge Scholars.

# Service-Learning Project Agreement

Bucknell University Grand Challenge Scholars Program

Student Name: _____ Phone: _____

Expected Graduation (Year/Month): _____ Major(s): _____

Grand Challenge(s) of interest: _____

GCSP Service-Learning Project Supervisor: _____

*This Agreement is to be completed by the student after discussion with his-her GCSP service-learning project supervisor and at least one member of the student's GCSP faculty-staff committee or the GCSP Director.*

SERVICE OBJECTIVES:  Describe the nature of the service activities in which you will be engaged, including the site or organization that will be served, what tasks or activities you will perform, and the work product or outcomes that will result from your service.

_____
_____
_____
_____
_____
_____
_____

LEARNING OBJECTIVES:  Describe what you hope to learn from this service-learning experience about the challenges and assets of the population with whom you will be working, about the community, about your Grand Challenge(s) of interest, and about yourself.  The learning objectives should be based on the needs of the site or organization involved and on the student's learning goals as related to the objectives of the GCSP service-learning requirements.

_____
_____
_____
_____
_____
_____

LOGISTICAL ARRANGEMENTS:  Describe how you will travel between campus and the site or organization, who will travel or work with you, whether there are any potential security or health concerns, and whether you require funds for the project.

_____
_____
_____
_____

_____

_____

STUDENT:  I agree to devote approximately_____ hours per _____ (time period) for a total of _____ hours, between _____ (date) and _____ (date).  I agree to complete paperwork needed by the site, organization or project supervisor, as needed.  Should concerns about my security and health or my ability to complete the service project arise, I agree to discuss these concerns immediately with the site/organization supervisor and/or my GCSP service-learning project supervisor.  At the conclusion of the project, I will submit a ~500 word reflection that describes my experience and whether the service and learning objectives identified above were realized.

Student Signature: _____ Date: _____

SERVICE-LEARNING PROJECT SUPERVISOR:  I agree to guide the student's work, to review the student's post-experience reflection, and to submit to the student and to the GCSP Director a brief assessment to confirm the service and learning objectives were met.

Project Supervisor Signature: _____ Date: _____

GCSP Director Signature: _____ Date: _____

# Appendix 4:  The GCSP Application Form

# Application for the Bucknell Grand Challenge Scholars Program

Please fill out the below application.  At the bottom, you'll find information on the other documents you need to upload to the Google folder created for your application.  When you have completed this application (including the two application essays) and uploaded your APR and your faculty endorsement, please email Professor Toole ttoole@bucknell.edu to let him know your Google folder is ready for review.  The deadline to apply is January 3, 2016, however, it would be helpful to let him know by December 15 if you might be interested in participating in the three-week GCSP course this summer entitled "Social Entrepreneurship in New Orleans."

Name:

Major(s):

Faculty Advisor(s):

Anticipated graduation month and year:

Which Grand Challenge(s) most interest you?  Please put a 1 next to the GC that you think you might be most interested in, a 2 next to your next favorite, … and a 3 next to your third favorite.  You can read about each Grand Challenge through this link.

___ Make solar energy economical

___ Provide energy from fusion

___ Develop carbon sequestration methods

___ Manage the nitrogen cycle

___ Provide access to clean water

___ Restore and improve urban infrastructure

___ Advance health informatics

___ Engineer better medicines

___ Reverse-engineer the brain

___ Prevent nuclear terror

___ Secure cyberspace

___ Enhance virtual reality

___ Advance personalized learning

___ Engineer the tools of scientific discovery

Comment: (optional)

The GCSP requires students to engage in the following five areas. Descriptions of the options for successfully completing these requirements can be found [here](). (These requirements are also provided below through links in the headers for the requirements.) While it is assumed that most applicants will not have completed any of these requirements, it will be helpful to know if you have already completed any of them and/or have specific plans for completing them by August 2016.

### *Research or Major Project:*
Please provide information here if you believe you have already completed the research or major project requirement by identifying the faculty member who supervised your work and when the work was performed. Please provide a 4-5 sentence description of the research/project so we can confirm it was sufficiently related to a Grand Challenge. Please provide the same information if you already have specific plans for performing research this spring or summer.

### *Service-learning:*
Please provide information here if you believe you have already completed or have plans underway to complete the service-learning requirement by identifying the activity and when you participated in it or will participate in it.

### *Global/Cross Cultural Dimension:*
Please provide information here if you believe you have already completed or have plans underway to complete the global perspective requirement.

### *Entrepreneurial activity:*
Please provide information here if you believe you have already completed or have plans underway to complete the entrepreneurship requirement.

If you have identified members of the GCSP Steering Committee (listed below) who you would like to serve on your subcommittee, please place a check next to their names.
___ Donna Ebenstein, Assoc. Professor of Biomedical Engineering
___ Peter Jansson, Assoc. Prof. of Electrical and Computer Engineering
___ Michael Johnson-Cramer, Director of the School of Management
___ Jan Knoedler, Prof. of Economics and Co-Director, Institute for Public Policy
___ Jessica Newlin, Asst. Professor of Civil & Env. Engineering
___ Felipe Perrone, Assoc. Professor of Computer Science
___ Nate Siegel, Asst. Professor of Mechanical Engineering
___ Mike Toole, GCSP Director, Assoc. Dean of Engineering
___ Brandon Vogel, Assoc. Professor of Chemical Engineering
___ Janice Butler, Director of Civil Engagement and Service-Learning
___ Pam Keiser, Exec. Director, Career Development Center
___ Jim Van Fleet, Library & IT research librarian

If there is a faculty member not listed above who might provide guidance for your research or other GCSP requirements, please identify them here:
_____

Please help us get to know you and understand your motivations for becoming a Grand Challenge Scholar by writing two brief essays below.

**Essay 1** - Please discuss in 500-750 words why you wish to become a Grand Challenge Scholar.

**Essay 2** - Please discuss in 250-500 words what you would bring to the GCSP.  Examples include an international perspective, an exceptional track record of collaboration, prior research in a topic related to a Grand Challenge, etc.

*In addition to completing the above form, please upload the following documents to your Google Drive application folder:*

1. *Your current academic progress report. (*Please click on the "Printer Friendly Version" before saving it to a PDF, then name the file "Last Name, APR")

2. *The completed* <u>*endorsement*</u> *from your academic adviser. (*The file name should be "Last Name, Endorsement".  If more convenient, your academic adviser can give a hardcopy of your endorsement directly to Prof. Toole as close to Jan. 5 as possible.)

*\*\*\*Don't forget to email Professor Toole at* <u>***ttoole@bucknell.edu***</u> *when everything is complete in your Google folder and ready for review.*

# Appendix 5: GCSP Application Academic Adviser Endorsement Form and Guidance for Academic Advisers

## Grand Challenge Scholars Program
## Academic Adviser Endorsement Form

**Instructions:**

Students: Please complete Part A and give this form to your faculty academic adviser. You will enter your application online using the Google Form link provided elsewhere. At the end of the online application process, you will be given a chance to create a pdf of your application. It is recommended that you save a copy in case your academic adviser wishes to receive a copy.

Advisers: Please complete Part B, print this form, sign it and either give a hardcopy of this form to Mike Toole (Dana 232) or scan it and email it to your advisee so it can be uploaded. The student must complete their application by Jan. 3 but your endorsement is not needed until Jan. 5. If you need more time, just let Mike know. Please note that you are encouraged but not expected to review your advisee's GCSP application. Your help is appreciated!

-----------------------------------------------------------------------------------------------------------------

**Part A** (to be completed by student)

Date: _____

Dear Professor _____,

I am applying to join the Grand Challenge Scholars Program and request that you endorse my application. Thank you for considering this request. I hereby waive my right to review your completed endorsement form.

Other comments, if any: _____
_____
_____


_____          _____
Signature of student                                      Printed name of student


-----------------------------------------------------------------------------------------------------------------

**Part B** (To be completed by faculty academic adviser)

Please check all that apply:

____ I have read or skimmed my advisee's GCSP application.

____ I endorse my advisee's application to join the Grand Challenge Scholars Program.

____ I have questions and/or concerns about my advisee's application that I would like to discuss with the GCSP Director.

Other comments, if any: _____
_____
_____


_____  _____   _____
Signature of Academic Adviser  Printed name of Academic Adviser           Date

Dear Faculty Colleague,

One or more of your advisees may request that you submit a faculty adviser endorsement form to support her or his application to be a Grand Challenge Scholar. Allow us to explain the purpose of the adviser endorsement and what a check on one or more of the lines means.

The form has two primary purposes. One purpose is to make sure that you know your advisee is applying to become a Grand Challenge Scholar, which will require her/him to complete five components of the GCSP that are intended to motivate and equip the student to tackle one or more of the 14 Grand Challenges: broadening curriculum, a major research project, service-learning, an entrepreneurial activity, and study abroad. (Many high achieving Bucknell students would likely complete three or more of these requirements even if they weren't Grand Challenge Scholars, but receiving the certificate from the National Academy of Engineering provides motivation to complete all five requirements.)

Having an advisee join the Grand Challenge Scholars Program may have two implications for your role as the faculty adviser. First, your advisee will wish to ensure that at least some of her/his Gen Ed, technical and free electives are relevant to the Grand Challenge in which she/he is most interested. Each GC Scholar will be assigned three members of the faculty and staff (typically members of the GCSP Steering Committee listed below) to advise them on completing their GCSP requirements, including giving them advice on what courses they should take that would be relevant to their GC of interest. GC Scholars are strongly encouraged to take ECON 103, a public policy course, such as UNIV 225, POLY 231 ECON 237, ENST 226, or ENST 245, and one or more of the electives relevant to their GC listed [here]. But the guidance of each Scholar's GCSP subcommittee should in no way pre-empt or supersede the course guidance of their regular academic adviser. If you ever sense that your role as academic adviser is being marginalized in anyway by the GCSP, please let us know.

The second component of the GCSP that may have implications for your role as academic adviser is the research requirement. This research requirement is typically completed through a summer research project, independent study for credit, or a sustained research project pursued as part of a Presidential Fellowship. Your GC Scholar advisee is therefore more likely to seek advice on how to line up such a research opportunity than are your other advisees. Again, the Scholar's GCSP subcommittee can guide the Scholar on how to search for a relevant research project, but their guidance should supplement, not supersede your own guidance.

Now allow us to explain the three "boxes" that are on the endorsement form. The line that reads "I endorse my advisee's application to join the Grand Challenge Scholars Program" is our way of asking you to confirm that you *sense* your advisee is sufficiently motivated, mature and disciplined to commit to completing a set of primarily co-curricular activities that are above what is required by normal degree requirements. We recognize that this confirmation might be difficult to provide if your advisee is a first or second year student, especially if you have never had her/him in class. We are certainly not asking you to confirm that you are 100% certain your advisee will complete her/his GCSP requirements or that you will make any special efforts to ensure she/he completes the requirements.

The line that reads "I have questions and/or concerns about my advisee's application that I would like to discuss with the GCSP Director" is a way for you to initiate dialogue about the GCSP or your advisee with the GCSP Director.  If you sense that a student has low initiative, difficulty following through on commitments, or facing some personal circumstances that would make it best NOT to take on any special program, we would like to have a discussion with you (while also complying with FERPA, of course).

The line that reads "I have read or skimmed my advisee's GCSP application" is provided purely for informational purposes, to see how many advisers have been asked to or have asked to review the student's application.

Thank you for supporting the Grand Challenge Scholars Program by provide faculty adviser endorsement forms for your advisees that apply to the GCSP.  We ask that you not hesitate to approach any of us with questions, concerns or suggestions for improving the GCSP at Bucknell.

Respectfully,
Members of the Bucknell GCSP Steering Committee
Janice Butler, Donna Ebenstein, Peter Jansson, Michael Johnson-Cramer, Pam Keiser, Jan Knoedler, Jessica Newlin, Felipe Perrone, Nate Siegel, Mike Toole, Jim Van Fleet, Brandon Vogel.

## Appendix 6: Achievements and Continuous Improvement

Over the nearly three years since Bucknell's GCSP was approved by the NAE National Steering Committee, the program has achieved notable successes and responded to nontrivial challenges. Successes include:

- Solicited applications and accepted 11 Scholars in January 2014, 19 Scholars in January 2015, and 20 Scholars in January 2016. The first five seniors are expected to graduate in May 2016. The current total of 50 Scholars includes 20 non-male students, 23 non-white students, 20 international students, 24 students receiving at least 20% financial aid during the academic year, and reasonable representation from each of the engineering majors.
- The first non-engineering student was accepted into the GCSP in January 2016. Currently a sophomore majoring in management, this student's success in The Grand Challenges foundation seminar motivated her to enroll in ENGR 252 (IDEAS Design course) and Pollution Control, and the KEEN Winter Interdisciplinary Design Experience (KWIDE), all taught by engineering faculty. It is hoped this student's success in courses and activities normally associated with engineering students will inspire other management and liberal arts students to follow similar curricular and extracurricular paths.
- The GCSP Steering Committee providing leadership for the GCSP represents a broad portion of the Bucknell campus.
- The courses associated with the GCSP have been successful interdisciplinary courses that match well with Bucknell's vision to offer interdisciplinary courses in a residential environment. The Grand Challenges foundation seminar has been housed within the Society and Technology Residential College, allowing the engineering and non-engineering students in the seminars to interact frequently outside of class. The online modules completed by Scholars who did not take the foundation seminar were well received by the students. The on-campus portion of the 2015 three-week summer course included 12 hours of class taught by faculty from the School of Management while the portion in Iceland included lectures and site tours by engineering and non-engineering instructors. The 2016 three-week summer course will be co-taught by an engineering professor and the Director of Civic Engagement and Service-Learning, who has led several service-learning trips to New Orleans.
- The funds raised from donors for the GCSP has totaled $185,000 and has enabled students receiving financial aid to participate in the three-summer courses.
- The GCSP has strengthened the College's relationship with the Office of Civic Engagement.
- Bucknell has received good exposure in the international engineering education community through our GCSP. Bucknell's GCSP Director has been serving as one of six members of the NAE GCSP National Steering Committee and was invited to give a presentation on our GCSP at a joint conference with the U.S. and Indian National Academies of Engineering. The Dean of Engineering and GCSP Director have attended several other conferences at the NAE, including a national letter of commitment ceremony at the White House.
- GC Scholars have been motivated and enabled to pursue special educational activities they would not have otherwise done, such as spending three-weeks studying entrepreneurship, accounting and finance, product ideation and development and touring

operating renewable energy facilities in Iceland, helping to design a living learning laboratory Greenhouse to be located near the water tour, designing a new irrigation system for the Community Garden, and performing summer research with engineering and non-engineering faculty.

- Several first year engineering students have contacted the GCSP Director to express they chose Bucknell in part because of the GCSP.

The implementation of the GCSP has certainly not been flawless. The Steering Committee has identified the need to:

- Eliminate the second required GCSP course for the reasons identified earlier in this document, including affordability;
- Improve the application process, including clarifying the role of the Faculty Adviser Endorsement Form;
- Better motivate Scholars to meet at least once a year with their assigned members of the GCSP Steering Committee;
- Convene the students, faculty and staff more often for lectures and dinners in order to better build and maintain a sense of community among GCSP Scholars and the GCSP Steering Committee;
- Develop an additional online module that helps students learn about the fourteen Grand Challenges.